

## § 17. Installation of a NEW VUV Spectrometer for Impurity Monitoring in CHS

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Since the most intense emission lines from impurities in toroidal plasmas tend to fall into vacuum ultraviolet (VUV) range, VUV spectroscopy is considerably important in the study of impurity transport mechanisms in such plasmas. Spectroscopic measurements in this spectral range had been tried also in Compact Helical System (CHS) by using normal incidence spectrometer.<sup>1)</sup> However, systematic studies for wavelength shorter than 40 nm which is inaccessible to the normal incidence spectrometer have not yet done in detail even though it contains important metallic impurity lines. In this fiscal year, we have developed a new grazing incidence VUV spectrometer system for monitoring line emission of metallic and non-metallic impurities in CHS.

The heart of the spectrometer is a toroidal flat field grating which can focus a spectral image on a flat plane. We have used an ion etched unequally ruled grating (Jobin Yvon, Type 541 00 200) whose spectral range is 10–110 nm (124–11 eV), which is enough for monitoring line emission of metallic and non-metallic impurities. Grooves density and focal length are around  $450 \text{ mm}^{-1}$  and 330 mm, respectively, which results in ideal reciprocal dispersion of  $2.70 \text{ nm/mm}$ .

The spectrometer has been installed in the center flange of 3O port of CHS so as to view the plasma along the equatorial plane in the horizontally elongated cross section. Schematic drawing of the setup is shown in Fig. 1 together with the vacuum magnetic surface of the standard CHS configuration ( $R_{ax}=92.1 \text{ cm}$ ). The spectrometer is electrically isolated from the CHS vac-

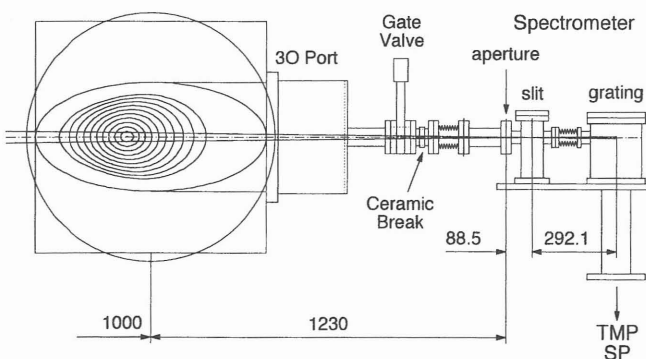


Fig. 1. Schematic drawing of the grazing incidence spectrometer installed in horizontally elongated cross section of CHS. The flux surfaces of the standard CHS configuration ( $R_{ax}=92.1 \text{ cm}$ ) is also shown.

uum chamber by a ceramic break attached behind a gate valve. The vacuum chamber of the spectrometer is independently pumped in oil-free environment by turbo-molecular and scroll pumps. In order to protect micro channel plate (MCP) detector against discharge, an small aperture is inserted near the entrance of the slit chamber to prevent gas flow into the spectrometer. The distance between the plasma center and the entrance slit is about 1.3 m.

Incident light is dispersed by the grating and then introduced onto the surface of MCP installed along the focal plane of the grating. Layout of the detector system is displayed in Fig. 2. The Chevron MCP of 40mm diameter (Burle, 3045FM) assembled on the vacuum flange enables us to measure overall spectrum from 10 to 110 nm at once. Intensified electron cloud impinge phosphor screen located behind MCP and then transferred into visible light image which is subsequently transmitted onto the surface of a 1024 channel CCD linear image sensor (Hamamatsu, S7010) via fiber optic plate (FOP) with a reduction ratio of 40:25. The CCD linear image sensor attached to the detector head is controlled by a personal computer via SCSI cable.

Installation of the spectrometer has already been completed and wavelength calibration using helium glow discharge has been done successfully. In the future, combination with AXUV photodiode array installed last year<sup>2)</sup> and another VUV spectrometer prepared in collaboration with JAERI will contribute to detailed understanding of impurity transport especially in discharges with internal transport barrier (ITB).

### References

- 1) Morita, S. et al.: Fusion Eng. Des. **34–35** (1997) 211.
- 2) Suzuki, C. et al.: Ann. Rep. NIFS (2001–2002) 297.

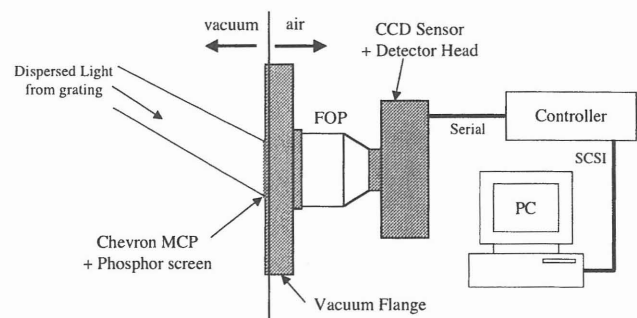


Fig. 2. Layout of detector system for the spectrometer. Phosphor screen (P20) behind Chevron micro channel plate (MCP) is connected to CCD linear image sensor via fiber optic plate (FOP).